Optimal Regional Insurance Provision: Do Federal Transfers Complement Local Debt?

Darong Dai Liqun Liu and Guoqiang Tian

Shanghai University of Finance and Economics
Texas A&M University
dai.darong@mail.shufe.edu.cn

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Introduction: Motivation

Two options for regional insurance provision:

- **Federal transfers** provide inter-regional insurance:
  - Sala-i-Martin and Sachs (1992), Persson and Tabellini (1996a, 1996b), Bucovetsky (1998), Lockwood (1999), Cornes and Silva (2000), Jüßen (2006), Farhi and Werning (2017).
- **Local debt** provides inter-generational insurance:
  - benefits of debt increase with the magnitude of risks and the degree of risk aversion (Gottardi, Kajii and Nakajima, 2015);
  - the design of optimal public debt that takes into account possible intergenerational conflicts is nontrivial (e.g., Rangel, 2003, 2005; Huber and Runkel, 2008; Dai, Liu and Tian, 2018).
- As (cross-region/cross-generation) risk-sharing public contracts,
  - *little is known about their joint design and optimal interaction!*

Introduction: Questions

Given the insurance role played along space and time dimensions, respectively:

- How would they behave when *jointly designed* by the central government?
- Under decentralized debt decisions, how would the interregional insurance provided by the central government *interact with* the intergenerational insurance provided locally?
- Shall they exhibit *complementarity* or *substitutability* in the course of implementation?
- *Optimal allocation of transfers* that respects each region's desire for local debt implies regions that desire *higher* debt should receive
  - *more* transfers under complementarity;
  - *less* transfers under substitutability.

Introduction: Why Are They Important?

- *Efficiency argument*: in terms of regional insurance provision *per se*, identify when they *should be* jointly (or separately) used.
- Identifying circumstances with *policy complementarity* justifies in some sense their *coexistence* in real-world federations.
- Identifying circumstances with *policy substitutability* creates a sort of *policy flexibility* for insurance provision:
  - Used simultaneously while targeting alternative policy goals, e.g.,
    - insurance provision vs. income redistribution;
    - insurance provision vs. local overborrowing;
    - insurance provision vs. interregional-externality correction.

Introduction: Shocks to Regional Economy

Two types of shocks:

- To the *degree of intergenerational externality (DIE)* (or durability) induced by intergenerational public goods (IPGs).

Example (IPGs)

Environmental protection, public school and public infrastructure.

- To the *degree of technological progress (DTP)* for producing IPGs.
  - Observable physical output vs. observable expenditure (input) of IPGs (Maskin and Riley, 1985; Lockwood, 1999).

Example (Input vs. output observability)

(1) Observable input: environmental protection, basic science, R&D, etc.; output is unobservable (or unmeasurable), at least in short run.
(2) Observable output: parks, public schools, highways, etc.

Introduction: Main Takeaways

Takeaway 1

In the case of shocks to DIE, federal transfers and local debt are *complementary*.

Takeaway 2

In the case of shocks to DTP, they are *complementary* with observable output of IPGs, but are *substitutive* with observable expenditure on (or input of) IPGs.

Analytical Framework: Environment

- A two-period federal economy: a federal government and n regions.
- Each region: a representative resident in each period.
- Each resident lives for one period only.
- The social welfare of region i, for $i = 1, 2, ..., n$, is given by

$$\underbrace{u_1(c_1^i) + g_1(G_1^i)}_{\text{utility of generation 1}} + \underbrace{u_2(c_2^i) + g_2(\theta^i G_1^i + G_2^i)}_{\text{utility of generation 2}}, \tag{1}$$

- $\theta^i \in (0, 1]$ measures DIE: bigger $\theta \Rightarrow$ higher DIE.
- Private budget constraints:

$$c_t^i + \underbrace{\tau_t^i}_{\text{lump-sum taxes}} = y_t$$

for $t = 1, 2$.

Analytical Framework: Public Budget Constraints

- Local governments collect lump-sum taxes for public goods provision.
- The center is responsible for enforcing intergovernmental grants.
- The fiscal budget constraints of region i:

$$G_1^i = \tau_1^i + \underbrace{b^i}_{\textbf{local debt}} + \underbrace{z^i}_{\textbf{federal transfers}};$$

$$\mathcal{G}_2^i = \xi^i G_2^i = \tau_2^i - (1+r)b^i.$$

- Output as a function of expenditure: $G_2^i = \mathcal{G}_2^i/\xi^i \equiv \rho^i \mathcal{G}_2^i$.
- $\rho^i > 0$ measures the DTP: bigger $\rho \Rightarrow$ higher DTP.

Analytical Framework: Regional Shocks and Information Structure

The sources of regional shocks:

- Compact support: $\theta \in [\underline{\theta}, \bar{\theta}] \equiv \Theta$, $\xi \in [\underline{\xi}, \bar{\xi}]$ or $\rho \in [\underline{\rho}, \bar{\rho}]$.
- Continuously distributed, and i.i.d. across regions.
- $f = F' > 0$ is the density function.

Information structure:

- Common knowledge: Supports, i.i.d. distribution and distribution function.
- Regional private information: Shock realization.
- Adverse-selection issue might arise!

Analytical Framework: Why Are They Relevant Private Information?

- Interpret θ as measuring the **quality** of local IPGs.
- Interpret ξ (or ρ) as measuring the **production efficiency** of local IPGs.
- Local governments are better informed about local conditions than the center (The Decentralization Theorem of Oates (1972)).

Analytical Framework: Timing of Game

Taking the shock to DIE for example:

- Shock occurs (nature moves first).
- Local governments privately observe shock realizations θ^i.
- The federal government offers the contract $\{b(\theta), z(\theta)\}$.
- The local governments simultaneously pick a contract (or equivalently report their types), and the game ends.

DIE Shock: The Problem of the Center

$$\max_{b(\theta),z(\theta)} EU$$

subject to

$$\begin{aligned}
EU &\equiv \int_{\underline{\theta}}^{\bar{\theta}} V(b(\theta), z(\theta), \theta) f(\theta) d\theta; \\
V(b(\theta), z(\theta), \theta) &\equiv \max_{c_1, c_2} \; u_1(c_1) + g_1(G_1) + u_2(c_2) + g_2(\theta G_1 + G_2) \\
&\qquad \text{s.t. private and local fiscal budget constraints;} \\
V(b(\theta), z(\theta), \theta) &\geq V(b(\theta'), z(\theta'), \theta) \quad \forall \theta' \neq \theta, \; \theta', \theta \in \Theta \; (\underline{\text{IC}}); \\
EU &\geq \int_{\underline{\theta}}^{\bar{\theta}} \max_{b(\theta)} V(b(\theta), 0, \theta) f(\theta) d\theta \; (\underline{\text{Ex ante IR}}); \\
\int_{\underline{\theta}}^{\bar{\theta}} z(\theta) f(\theta) d\theta &\leq 0 \; (\underline{\text{Federal budget}}).
\end{aligned}$$

DIE Shock: Rewrite The Problem of the Center

- Single-crossing property is satisfied.

$$\max \int_{\underline{\theta}}^{\bar{\theta}} v(\theta) f(\theta) d\theta$$

subject to

$$\begin{aligned} v(\theta) &\equiv V(b(\theta), z(\theta), \theta); \\ \dot{v}(\theta) &= g_2'(\theta G_1(\theta) + G_2(\theta)) G_1(\theta) \ (\underline{\text{FOIC}}); \\ \dot{b}(\theta) &\geq 0 \ (\underline{\text{SOIC}}); \\ \int_{\underline{\theta}}^{\bar{\theta}} z(\theta) f(\theta) d\theta &\leq 0 \ (\underline{\text{Federal budget}}). \end{aligned}$$

- Write the Hamiltonian and characterize the optimal solutions.

DIE Shock: Full-Information Benchmark

- For all types, the intertemporal rate of substitution between current and future public goods consumption equals intertemporal rate of transformation:

$$\frac{g_1'(G_1^{FB}(\theta))}{g_2'(\theta G_1^{FB}(\theta) + G_2^{FB}(\theta))} = 1 + r - \theta \text{ for any } \theta \in \Theta.$$

- Full insurance is achievable, namely that the consumption of period-2 public goods is the same regardless of the shock realization:

$$V_z\left(b^{FB}(\theta), z^{FB}(\theta), \theta\right) = \gamma \text{ for any } \theta \in \Theta,$$

in which $\gamma > 0$ denotes the Lagrangian multiplier on the federal budget constraint.

DIE Shock: Incomplete Insurance

Assumption 1

$-\theta G_1 g_2'' \leq g_2'$ for all $\theta \in (\underline{\theta}, \bar{\theta})$.

- Assumption 1 holds for log and power utility functions.

Suppose there is no bunching. Then we have:

- The intertemporal allocation is **not distorted only at** the endpoints of shock distribution:

$$\frac{g_1'(G_1^*(\theta))}{g_2'(\theta G_1^*(\theta) + G_2^*(\theta))} \begin{cases} = & 1 + r - \theta \quad \text{for } \theta \in \{\underline{\theta}, \bar{\theta}\}; \\ < & 1 + r - \theta \quad \text{for } \theta \in (\underline{\theta}, \bar{\theta}). \end{cases}$$

- Under Assumption 1, insurance is incomplete:

$$V_z\left(b^*(\theta), z^*(\theta), \theta\right) \begin{cases} = & \gamma/\mu_1(\theta) \quad \text{for } \theta \in \{\underline{\theta}, \bar{\theta}\}; \\ < & \gamma/\mu_1(\theta) \quad \text{for } \theta \in (\underline{\theta}, \bar{\theta}). \end{cases}$$

DIE Shock: Implementation

- Autonomy in the choice of local debt: $\max_{b(\theta)} V(b(\theta), z, \theta)$, $\forall z$.
- The intertemporal rate of substitution equals the intertemporal rate of transformation.

Theorem (Policy Complementarity (PC))

The grant scheme $z^*(b)$ that decentralizes the asymmetric information optimum $\{b^*(\theta), z^*(\theta)\}_{\theta\in\Theta}$ is a nonlinear nondecreasing function of b, almost everywhere differentiable, with the slope

$$\frac{dz^*}{db} \begin{cases} = 0 & \text{for } b \in \{b^*(\underline{\theta}), b^*(\bar{\theta})\}; \\ > 0 & \text{for } b \in (b^*(\underline{\theta}), b^*(\bar{\theta})). \end{cases}$$

- *Higher θ* $\underbrace{\Rightarrow}_{SOIC}$ *higher b* $\underbrace{\Rightarrow}_{PC}$ *higher z.*

DTP Shock: The Problem of the Center

- Assume observability of expenditure on IPGs.

$$\max \int_{\underline{\rho}}^{\bar{\rho}} v(\rho) f(\rho) d\rho$$

subject to

$$\begin{aligned}
v(\rho) &= V(b(\rho), z(\rho), \rho); \\
V(b(\rho), z(\rho), \rho) &\equiv \max_{c_1, c_2} u_1(c_1) + g_1(G_1) + u_2(c_2) + g_2(\theta G_1 + \overbrace{\rho \mathcal{G}_2}^{G_2}) \\
&\quad \text{s.t. private and local fiscal budget constraints;} \\
\dot{v}(\rho) &= g_2' \left(\theta G_1(\rho) + \rho \mathcal{G}_2(\rho)\right) \mathcal{G}_2(\rho) \ (\underline{\text{FOIC}}); \\
\dot{b}(\rho) &\leq 0 \ (\underline{\text{SOIC}}); \\
\int_{\underline{\rho}}^{\bar{\rho}} z(\rho) f(\rho) d\rho &\leq 0 \ (\underline{\text{Federal budget}}).
\end{aligned}$$

DTP Shock: Observable Expenditure on IPGs

- Implementation requires policy substitutability (PS):

$$\frac{dz^*}{db} \begin{cases} = 0 & \text{for } b \in \{b^*(\bar{\rho}), b^*(\underline{\rho})\}; \\ < 0 & \text{for } b \in (b^*(\bar{\rho}), b^*(\underline{\rho})). \end{cases}$$

- *Higher* $\rho \underbrace{\Rightarrow}_{SOIC}$ *lower* $b \underbrace{\Rightarrow}_{PS}$ *higher* z*.*
- Implication for the *optimal funding of IPGs*, such as environmental protection and basic science, whose output is unobservable (at least in short run):
  - Higher DTP: more federal transfers plus less local borrowing.
  - Lower DTP: less federal transfers plus more local borrowing.

Conclusion: Optimal Regional Insurance Provision

- *A rationale for the usefulness of private insurance* as
  - public insurance is *incomplete* under asymmetric information between the center and regions, regardless of the source of shocks.
- *The source of shocks* as well as *the type of observability under the same source of shocks* matters for
  - judging whether gant and debt should be *used in tandem or not* in terms of regional insurance provision.

Table: Grant-debt interaction in implementing welfare optimum

Interaction	**DIE**	**DTP/Input**	**DTP/Output**
Complementary	✓		✓
Substitutive		✓	